

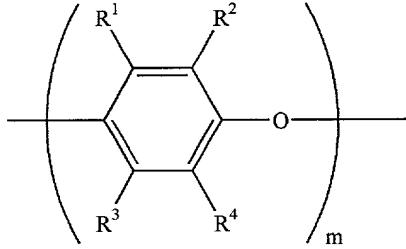
Claims

[c1] 1. A thermoset composition, comprising:
a functionalized poly(arylene ether);
an alkenyl aromatic monomer;
an acryloyl monomer; and
a conductive agent.

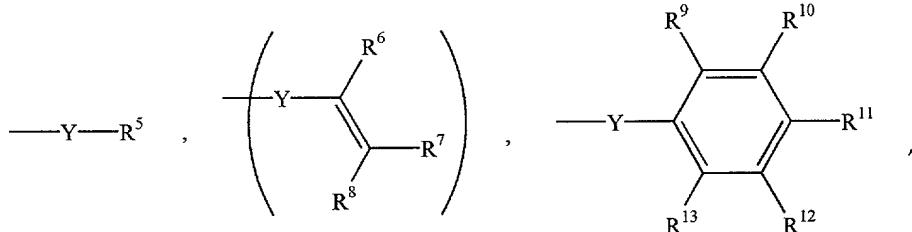
[c2] 2. The composition of Claim 1, wherein the functionalized poly(arylene ether) is a capped poly(arylene ether) having the structure



wherein Q is the residuum of a monohydric, dihydric, or polyhydric phenol; y is 1 to 100; J comprises recurring units having the structure

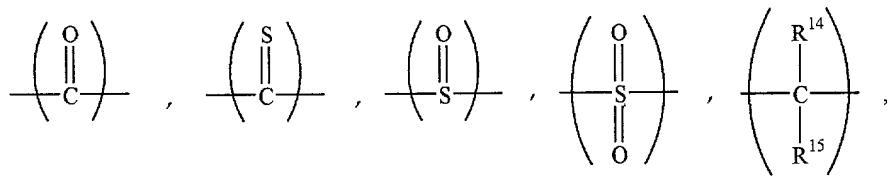


wherein R^1 to R^4 are each independently selected from the group consisting of hydrogen, halogen, primary or secondary C_1 to C_{12} alkyl, C_2 to C_{12} alkenyl, C_2 to C_{12} alkynyl, C_1 to C_{12} aminoalkyl, C_1 to C_{12} hydroxyalkyl, phenyl, C_1 to C_{12} haloalkyl, C_1 to C_{12} hydrocarboxy, and C_2 to C_{12} halohydrocarboxy. wherein at least two carbon atoms separate the halogen and oxygen atoms; m 1 to about 200; and K is a capping group selected from the group consisting of



wherein R^5 is C_1 to C_{12} alkyl; R^6 to R^8 are each independently selected from the group consisting of hydrogen, C_1 to C_{12} alkyl, C_2 to C_{12} alkenyl, C_6 to C_{18} aryl, C_7 to C_{18} alkyl-substituted aryl, C_7 to C_{18} aryl-substituted alkyl, C_2 to C_{12} alkoxy carbonyl, C_7 to C_{18} aryloxy carbonyl, C_8 to C_{18} alkyl-substituted aryloxy carbonyl, C_8 to C_{18} aryl-substituted alkoxy carbonyl, nitrile, formyl, carboxylate, imidate, and thiocarboxylate; R^9 to R^{13} are each independently

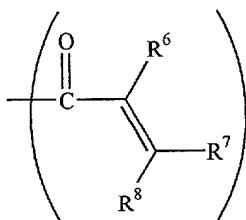
selected from the group consisting of hydrogen, halogen, C₁–C₁₂ alkyl, hydroxy, and amino; and wherein Y is a divalent group selected from the group consisting of



wherein R¹⁴ and R¹⁵ are each independently selected from the group consisting of hydrogen and C₁–C₁₂ alkyl.

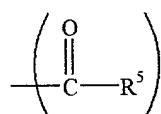
[c3] 3. The composition of Claim 2, wherein Q is the residuum of a monohydric phenol.

[c4] 4. The composition of Claim 2, wherein the capped poly(arylene ether) at least one capping group having the structure



wherein R⁶–R⁸ are each independently selected from the group consisting of hydrogen, C₁–C₁₂ alkyl, C₂–C₁₂ alkenyl, C₆–C₁₈ aryl, C₇–C₁₈ alkyl-substituted aryl, C₇–C₁₈ aryl-substituted alkyl, C₂–C₁₂ alkoxy carbonyl, C₇–C₁₈ aryloxy carbonyl, C₈–C₁₈ alkyl-substituted aryloxy carbonyl, C₈–C₁₈ aryl-substituted alkoxy carbonyl, nitrile, formyl, carboxylate, imidate, and thiocarboxylate.

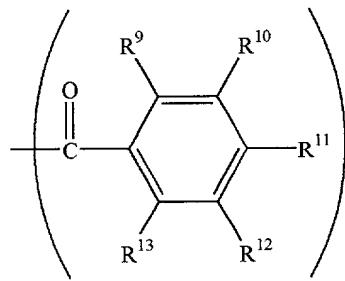
[c5] 5. The composition of Claim 2, wherein the capped poly(arylene ether) a capping group having the structure



wherein R⁵ is C₁–C₁₂ alkyl.

[c6]

6. The composition of Claim 2, wherein the capped poly(arylene ether) at least one capping group having the structure

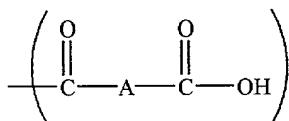


wherein R⁹–R¹³ are each independently selected from the group consisting of hydrogen, halogen, C₁–C₁₂ alkyl, hydroxy, and amino.

[c7] 7. The composition of Claim 6, wherein at least one of R⁹ and R¹³ is hydroxyl.

[c8] 8. The composition of Claim 7, further comprising further comprising a multivalent metal ion selected from Groups IIA, IIIA, and IB–VIIIB of the periodic table.

[c9] 9. The composition of Claim 2, wherein the capped poly(arylene ether) at least one capping group having the structure

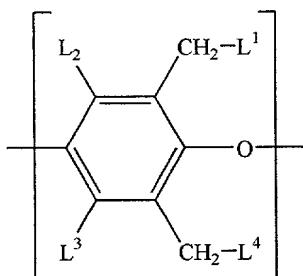


wherein A is a saturated or unsaturated C₂–C₁₂ divalent hydrocarbon group.

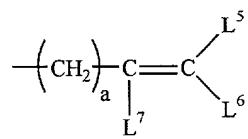
[c10] 10. The composition of Claim 9, further comprising a multivalent metal ion selected from Groups IIA, IIIA, or IB–VIIIB of the periodic table.

[c11]

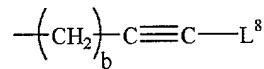
11. The composition of Claim 1, wherein the functionalized poly(arylene ether) is a ring-functionalized poly(arylene ether) comprising repeating units having the structure



wherein each L¹–L⁴ is independently hydrogen, an alkenyl group, or an alkynyl group; wherein the alkenyl group is represented by



wherein L^5 to L^7 are independently hydrogen or methyl, and a is an integer from 1 to 4; wherein the alkynyl group is represented by



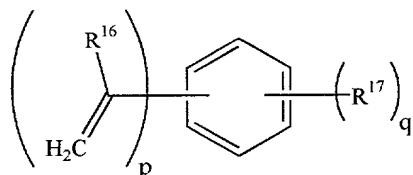
wherein L^8 is hydrogen, methyl, or ethyl, and b is an integer from 1 to 4; and wherein about 0.02 mole percent to about 25 mole percent of the total L^1 to L^4 substituents in the ring-functionalized poly(arylene ether) are alkenyl and/or alkynyl groups.

[c12] 12. The composition of Claim 1, wherein the functionalized poly(arylene ether) is substantially free of amine substituents.

[c13] 13. The composition of Claim 1, wherein the functionalized poly(arylene ether) has an intrinsic viscosity of about 0.15 to about 0.30 deciliters per gram measured at 25 °C in chloroform.

[c14] 14. The composition of Claim 1, comprising about 1 to about 70 parts by weight of the functionalized poly(arylene ether) per 100 parts by weight total of the functionalized poly(arylene ether), the alkenyl aromatic monomer, and the acryloyl monomer.

[c15] 15. The composition of Claim 1, wherein the alkenyl aromatic monomer has the structure



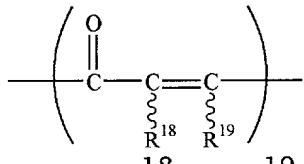
wherein each R^{16} is independently selected from the group consisting of hydrogen, $\text{C}_1\text{--C}_{12}$ alkyl, $\text{C}_2\text{--C}_{12}$ alkenyl, $\text{C}_2\text{--C}_{12}$ alkynyl, and $\text{C}_6\text{--C}_{18}$ aryl; each R^{17} is independently selected from the group consisting of halogen, $\text{C}_1\text{--C}_{12}$ alkyl, $\text{C}_1\text{--C}_{12}$ alkoxy, and $\text{C}_6\text{--C}_{18}$ aryl; p is 1 to 4; and q is 0 to 5.

[c16] 16. The composition of Claim 1, wherein the alkenyl aromatic monomer

comprises at least one alkenyl aromatic monomer selected from the group consisting of styrene, alpha-methylstyrene, 2-methylstyrene, 3-methylstyrene, 4-methylstyrene, 2-t-butylstyrene, 3-t-butylstyrene, 4-t-butylstyrene, 1,3-divinylbenzene, 1,4-divinylbenzene, 1,3-diisopropenylbenzene, 1,4-diisopropenylbenzene, styrenes having from 1 to 5 halogen substituents on the aromatic ring, and mixtures comprising at least one of the foregoing alkenyl aromatic monomers.

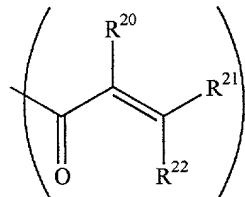
[c17] 17. The composition of Claim 1, comprising about 30 to about 98 parts by weight of the alkenyl aromatic monomer per 100 parts by weight total of the functionalized poly(arylene ether), the alkenyl aromatic monomer, and the acryloyl monomer.

[c18] 18. The composition of Claim 1, wherein the acryloyl monomer comprises at least one acryloyl moiety having the structure



wherein R¹⁸ and R¹⁹ are each independently selected from the group consisting of hydrogen and C₁-C₁₂ alkyl, and wherein R¹⁸ and R¹⁹ may be disposed either *cis* or *trans* about the carbon-carbon double bond.

[c19] 19. The composition of Claim 1, wherein the acryloyl monomer comprises at least one acryloyl moiety having the structure



wherein R²⁰-R²² are each independently selected from the group consisting of hydrogen, C₁-C₁₂ alkyl, C₂-C₁₂ alkenyl, C₆-C₁₈ aryl, C₇-C₁₈ alkyl-substituted aryl, C₇-C₁₈ aryl-substituted alkyl, C₂-C₁₂ alkoxy carbonyl, C₇-C₁₈ aryloxy carbonyl, C₈-C₁₈ alkyl-substituted aryloxy carbonyl, C₈-C₁₈ aryl-substituted alkoxy carbonyl, nitrile, formyl, carboxylate, imidate, and thiocarboxylate.

[c20] 20.The composition of Claim 19, wherein the acryloyl monomer comprises at least two acryloyl moieties.

[c21] 21.The composition of Claim 19, wherein the acryloyl monomer comprises at least three acryloyl moieties.

[c22] 22.The composition of Claim 1, wherein the acryloyl monomer comprises at least one acryloyl monomer selected from the group consisting of trimethylopropane tri(meth)acrylate, 1,6-hexanediol di(meth)acrylate, ethylene glycol di(meth)acrylate, propylene glycol di(meth)acrylate, cyclohexanedimethanol di(meth)acrylate, butanediol di(meth)acrylate, glycol di(meth)acrylate, triethylene glycol di(meth)acrylate, isobornyl (meth) acrylate, methyl (meth)acrylate, and mixtures comprising at least one of the foregoing acryloyl monomers.

[c23] 23.The composition of Claim 1, comprising about 1 to about 69 parts by weight of the acryloyl monomer per 100 parts by weight total of the functionalized poly (arylene ether), the alkenyl aromatic monomer, and the acryloyl monomer.

[c24] 24.The composition of Claim 1, wherein the conductive agent is selected from the group consisting of graphite, conductive carbon black, conductive carbon fibers, metal fibers, metal particles, and particles of intrinsically conductive polymers.

[c25] 25.The composition of Claim 1, wherein the conductive agent comprises graphite.

[c26] 26.The composition of Claim 1, wherein the conductive agent comprises conductive carbon fibers having an average diameter of about 3.5 to about 500 nanometers.

[c27] 27.The composition of Claim 1, comprising about 5 to about 95 weight percent conductive agent, based on the total weight of the composition.

[c28] 28.The composition of Claim 1, further comprising a curing catalyst.

[c29] 29.The composition of Claim 28, wherein the curing catalyst is selected from

the group consisting of benzoyl peroxide, dicumyl peroxide, methyl ethyl ketone peroxide, lauryl peroxide, cyclohexanone peroxide, t-butyl hydroperoxide, t-butyl benzene hydroperoxide, t-butyl peroctoate, 2,5-dimethylhexane-2,5-dihydroperoxide, 2,5-dimethyl-2,5-di(t-butylperoxy)-hex-3-yne, di-t-butylperoxide, t-butylcumyl peroxide, alpha,alpha'-bis(t-butylperoxy-m-isopropyl)benzene, 2,5-dimethyl-2,5-di(t-butylperoxy)hexane, dicumylperoxide, di(t-butylperoxy isophthalate, t-butylperoxybenzoate, 2,2-bis(t-butylperoxy)butane, 2,2-bis(t-butylperoxy)octane, 2,5-dimethyl-2,5-di(trimethylsilyl)peroxide, trimethylsilylphenyltriphenylsilyl peroxide, 2,3-dimethyl-2,3-diphenylbutane, 2,3-trimethylsilyloxy-2,3-diphenylbutane, and mixtures comprising at least of the foregoing curing catalysts.

[c30] 30. The composition of Claim 28, further comprising a curing promoter.

[c31] 31. The composition of Claim 30, wherein the curing promoter is selected from the group consisting of cobalt naphthanate, N,N-dimethylaniline, N,N-diethylaniline, and mixtures comprising at least one of the foregoing curing promoters.

[c32] 32. The composition of Claim 1, further comprising an additive selected from the group consisting of flame retardants, flame retardant synergists, mold release agents and other lubricants, antioxidants, thermal stabilizers, ultraviolet stabilizers, pigments, dyes, colorants, anti-static agents, fibrous reinforcements, disc-shaped fillers, low-aspect ratio fillers, synthetic resins, natural resins, thermoplastic elastomers, low profile additives, and combinations comprising at least one of the foregoing additives.

[c33] 33. A thermoset composition, comprising:
about 1 to about 70 parts by weight of a functionalized poly(arylene ether);
about 30 to about 98 parts by weight of an alkenyl aromatic monomer;
about 1 to about 69 parts by weight of an acryloyl monomer; and
about 5 to about 95 weight percent of a conductive agent;
wherein the parts by weight of the functionalized poly(arylene ether), the alkenyl aromatic monomer, and the acryloyl monomer sum to 100; and wherein the

amount of the conductive agent is based on the total weight of the composition.

[c34] 34. A thermoset composition, comprising:

about 10 to about 50 parts by weight of a methacrylate-capped poly(arylene ether);

about 40 to about 80 parts by weight of a monofunctional alkenyl aromatic monomer;

about 5 to about 50 parts by weight of a polyfunctional acryloyl monomer;

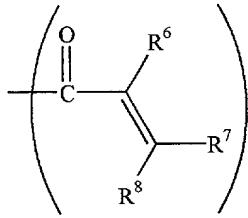
about 1 to about 5 parts by weight of a curing catalyst; and

about 20 to about 95 weight percent of graphite;

wherein parts by weight of the methacrylate-capped poly(arylene ether), the monofunctional alkenyl aromatic monomer, the polyfunctional acryloyl monomer, and the curing catalyst are based on 100 total parts for the methacrylate-capped poly(arylene ether), the monofunctional alkenyl aromatic monomer, and the polyfunctional acryloyl monomer; and wherein the weight percent of the graphite is based on the total weight of the composition.

[c35] 35. A thermoset composition, comprising:

a capped poly(arylene ether) comprising a capping group having the structure



wherein R⁶ - R⁸ are each independently hydrogen or C₁ - C₁₂ alkyl; an alkenyl aromatic monomer;

an acryloyl monomer; and

a conductive agent.

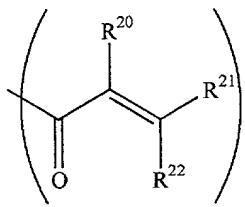
[c36]

36. A thermoset composition, comprising:

a functionalized poly(arylene ether);

an alkenyl aromatic monomer;

an acryloyl monomer comprising at least one acryloyl moiety having the structure



wherein R²⁰–R²² are each independently selected from the group consisting of hydrogen, C₁–C₁₂ alkyl, C₂–C₁₂ alkenyl, C₆–C₁₈ aryl, C₇–C₁₈ alkyl-substituted aryl, C₇–C₁₈ aryl-substituted alkyl, C₂–C₁₂ alkoxy carbonyl, C₇–C₁₈ aryloxy carbonyl, C₈–C₁₈ alkyl-substituted aryloxy carbonyl, C₈–C₁₈ aryl-substituted alkoxy carbonyl, nitrile, formyl, carboxylate, imidate, and thiocarboxylate; and
a conductive agent.

[c37] 37. A thermoset composition, comprising the reaction product of:
a functionalized poly(arylene ether);
an alkenyl aromatic monomer;
an acryloyl monomer; and
a conductive agent.

[c38] 38. The composition of Claim 37, wherein the composition after curing has a glass transition temperature of at least about 120 °C.

[c39] 39. An article comprising the composition of Claim 37.

[c40] 40. An electrochemical cell comprising the composition of Claim 37.

[c41] 41. A fuel cell bipolar plate comprising the composition of Claim 37.

[c42] 42. A method of preparing a thermoset composition, comprising: blending a functionalized poly(arylene ether), an alkenyl aromatic monomer, an acryloyl monomer, and a conductive agent to form an intimate blend.

[c43] 43. The method of Claim 42, wherein blending comprises mixing with a mixing energy of about 0.025 to about 50 kilojoules/L.

[c44] 44. The method of Claim 42, wherein blending comprises mixing with a mixing power of about 5 to about 750 watts/liter.

[c45] 45. The method of Claim 42, wherein blending comprises mixing with a tip speed of about 0.05 to about 35 meters/sec.

[c46] 46. A method of preparing a thermoset composition, comprising:
mixing a poly(arylene ether) and an alkenyl aromatic monomer to form a first blend;
mixing the first blend with a capping agent under conditions suitable to promote reaction of the poly(arylene ether) and the capping agent to form a capped poly(arylene ether), thereby forming a second blend comprising the capped poly(arylene ether) and the alkenyl aromatic monomer;
mixing the second blend with an acryloyl monomer and a conductive agent.